

**UNCLASSIFIED**

**AD**

**404 913**

**DEFENSE DOCUMENTATION CENTER**

**FOR**

**SCIENTIFIC AND TECHNICAL INFORMATION**

**CAMERON STATION, ALEXANDRIA, VIRGINIA**



**UNCLASSIFIED**

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

63-35

AMRL-TDR-63-13

CAT: 63-35  
ASTIA

AS AD 404913

# A BIBLIOGRAPHY OF THE EFFECTS OF TEMPERATURE ON HUMAN PERFORMANCE

John Wing  
Robert M. Touchstone

TECHNICAL DOCUMENTARY REPORT NO. AMRL-TDR-63-13

FEBRUARY 1963

404 913

BEHAVIORAL SCIENCES LABORATORY  
6570th AEROSPACE MEDICAL RESEARCH LABORATORIES  
AEROSPACE MEDICAL DIVISION  
AIR FORCE SYSTEMS COMMAND  
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

Project No. 1710, Task No. 171002

DDC  
RECEIVED  
MAY 29 1963  
ASTIA A

## NOTICES

When US Government drawings, specifications, or other data are used for any purpose other than a definitely related government procurement operation, the government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise, as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Qualified requesters may obtain copies from ASTIA. Orders will be expedited if placed through the librarian or other person designated to request documents from ASTIA.

Do not return this copy. Retain or destroy.

Stock quantities available at Office of Technical Services, Department of Commerce, \$0.75.

### Change of Address

Organizations receiving reports via the 6570th Aerospace Medical Research Laboratories automatic mailing lists should submit the addressograph plate stamp on the report envelope or refer to the code number when corresponding about change of address.

**FOREWORD**

**This bibliography was prepared in the Environmental Stress Section, Training Research Branch, Behavioral Sciences Laboratory, under Project No. 1710, "Training, Personnel, and Psychological Stress Aspects of Bioastronautics," Task No. 171002, "Performance Effects of Environmental Stress." Dr. Ross L. Morgan served as Project Scientist and Dr. W.D. Chiles as Task Scientist. The bibliography was initiated in late 1961 and completed in October 1962.**

### ABSTRACT

This bibliography lists technical reports and journal articles dealing with human performance under both high and low ambient temperatures. The articles and reports have been grouped into sections covering five major performance areas: (1) Sensory Thresholds and Simple Reaction Time, (2) Attention and Perception, (3) Psychomotor Performance, (4) Heavy or Prolonged Physical Work, and (5) Mental Performance. A sixth section of the bibliography lists references which review portions of the literature. All the references have been coded as to whether they deal primarily with the effects of high or low ambient temperatures. An author index is included.

### PUBLICATION REVIEW

This technical documentary report has been reviewed and is approved.

*Walter F. Grether*  
WALTER F. GRETHER  
Technical Director  
Behavioral Sciences Laboratory

## TABLE OF CONTENTS

	Page
INTRODUCTION . . . . .	1
LIST OF ABBREVIATIONS USED IN THE BIBLIOGRAPHY . . . . .	2
BIBLIOGRAPHY	
I.    SENSORY THRESHOLDS AND SIMPLE REACTION TIME . . . . .	3
II.   ATTENTION (VIGILANCE) AND PERCEPTION . . . . .	5
III.  PSYCHOMOTOR PERFORMANCE . . . . .	7
IV.   HEAVY OR PROLONGED PHYSICAL WORK . . . . .	11
V.    MENTAL PERFORMANCE . . . . .	13
VI.   ANALYSES AND PARTIAL REVIEWS . . . . .	15
AUTHOR INDEX . . . . .	17

## A BIBLIOGRAPHY OF THE EFFECTS OF TEMPERATURE ON HUMAN PERFORMANCE

### INTRODUCTION

To the authors' knowledge, there exists no published bibliography of human performance under temperature extremes. The present bibliography lists unclassified studies (and reviews of studies) dealing with the effects of high and low ambient temperatures on human performance. Studies of comfort evaluation or tolerance limits are not included, nor are studies exclusively concerned with physiological as opposed to psychological functions. It does contain a few studies which are primarily physiological in nature but which also contain psychological data.

The authors have attempted to compile a comprehensive listing of all the reports and articles published on this topic in the English language. This was done by a systematic search of the literature as far back as 1952. The bibliographies attached to the reports and articles uncovered by this search were then examined for reports and articles which had been missed or which had been produced prior to 1952. Such a method of search cannot be exhaustive, and several relevant titles may have been omitted. The search was based primarily on a scanning of the Psychological Abstracts and a bibliographic search performed by ASTIA. This was supplemented by separate searches of Aerospace Medicine and Biology: an Annotated Bibliography and the following journals: Armed Forces Medical Journal, Ergonomics, Federation Proceedings, Human Factors Bulletin, Journal of Applied Psychology, Journal of Aviation Medicine, Journal of Engineering Psychology, Journal of Environmental Sciences, Journal of Experimental Psychology, and the Journal of Occupational Medicine.

The entries reported have been grouped into sections covering five broad performance areas: (1) Sensory Thresholds and Simple Reaction Time, (2) Attention (including vigilance) and Perception, (3) Psychomotor Performance, (4) Heavy or Prolonged Physical Work, and (5) Mental Performance. A sixth section lists articles and reports which present general analyses of the problem or which review some portion of the literature in this area. The authors were unable to find a really complete and detailed review of performance under temperature extremes.

Certain articles or reports were judged to contain findings pertinent to more than one performance area. These are therefore cited several times in the bibliography. Within each performance area there are studies concerned with the effects of high temperatures, low temperatures or both. To aid in locating all high temperature or all low temperature studies, an H (high) or L (low) has been placed in the right-hand margin opposite those studies dealing with just one extreme or the other. Studies which deal with the effects of both high and low ambient temperatures have no entry in the margin.

An Author Index is provided for easy access to all the different publications by a given author.

One final note should be added concerning the form used in citing each article. The form was selected with an eye to providing as much information as possible about the origin of the report. However, in order to conserve space, certain abbreviations have been employed. A list of these abbreviations precedes the bibliography. To aid in obtaining copies of reports, ASTIA documentary numbers (AD or ATT) have been added at the end of each citation, whenever these numbers were known.



## LIST OF ABBREVIATIONS USED IN THE BIBLIOGRAPHY

AAL	Arctic Aeromedical Laboratory
AF	Air Force
AMC	Air Material Command
AMRDC	Army Medical Research and Development Command
AMRL	Army Medical Research Laboratories
ASHVE	American Society of Heating and Ventilating Engineers
APU	Applied Psychology (Research) Unit
BAFB	Brooks Air Force Base
CAV	Committee on Armored Vehicles
CCI	Committee on Clinical Investigation
CRU	Climate Research Unit
DA	Department of the Army
DRNL	Defense Research Northern Laboratory
FPRC	Flying Personnel Research Committee
GSA	Ground Signal Agency
HEL	Human Engineering Laboratory
IAM	Institute of Aviation Medicine
LAFB	Ladd Air Force Base
MPRC	Military Personnel Research Committee
NCB	National Coal Board
NMRI	Naval Medical Research Institute
NRCC	National Research Council of Canada
ONR	Office of Naval Research
PRB	Personnel Research Branch
PTB	Personnel and Training Branch
QRDC	Quartermaster Research and Development Center
RAF	Royal Air Force
RAFB	Randolph Air Force Base
RDD	Research and Development Division
RNP	Royal Naval Personnel
SAM	School of Aviation Medicine
SC	Signal Corps
SDC	Special Devices Center
SCSCF	San Diego State College Foundation
WADC	Wright Air Development Center
WADD	Wright Air Development Division
WPAFB	Wright-Patterson Air Force Base

## SECTION I

## SENSORY THRESHOLDS AND SIMPLE REACTION TIME

1. Bartlett, D. J., and D. G. C. Gronow, Manual Dexterity and Tactile Sensitivity in the Cold, FPRC Report 806, RAF IAM, England, November 1952. AD 106 827. L
2. Craik, K. J. W., and S. J. Macpherson, Effects of Cold upon Hand Movement and Reaction Time, MPRC-BPC Report 43/196, CAV, England, 1943. L
3. Crocker, J. F., and C. R. Waitz, A Heat Pulse Oven for Study of Human Thermal Tolerance, WADD Report 60-733, WPAFB, Ohio, December 1960. H
4. Debons, A., and W. D. Chiles, The Effects of Cold on Psychophysical Weight Judgments: A Methodological Study, WADC Technical Report 57-305 WPAFB, Ohio, 1957. AD 131 004. L
5. Ebaugh, F. G., and B. Thauer, "Influence of Various Environmental Temperatures on the Cold and Warmth Thresholds," J. Appl. Physiol., Vol 3, p 173, 1950.
6. Forlano, G., "The Effect of Ambient Temperatures upon Reaction Time," Tech. Data Digest, Vol 15, pp 18-26, 1950.
7. Forlano, G., J. E. Barmack, and J. D. Coakley, The Effect of Ambient and Body Temperatures upon Reaction Time, SDC Report R-151-1-13, ONR, Washington, D. C., March 1948. ATI 41 253.
8. Kleitman, N., S. Titelbaum, and P. Feiveson, "The Effect of Body Temperature on Reaction Time," Amer. J. Physiol., Vol 121, pp 495-501, 1938. L
9. Mackworth, N. H., "Finger Numbness in Very Cold Winds," J. Appl. Physiol., Vol 5, pp 533-543, 1953. L
10. McCleary, R. A., Psychophysiological Effects of Cold. The Role of Skin-Temperature and Sensory Sensitivity in Manual Performance Decrement, SAM Project 21-1202-0004, Report 1, RAFB, Texas, January 1953. AD 8093. L
11. Mills, A. W., "Finger Numbness and Skin Temperature," J. Appl. Physiol., Vol 9, pp 447-450, 1956. AD 144 497. L
12. Provins, K. A., and R. Morton, "Tactile Discrimination and Skin Temperature," J. Appl. Physiol., Vol 15, pp 155-160, 1960.
13. Russell, R. W., "Environmental Conditions and Behaviour: Effects of Climate. Effects of Varying Ambient Temperature on Tactile and Kinesthetic Sensitivity and on Certain Tracking Skills," Bull. Brit. Psychol. Soc., Vol 26 (Inset), p 5, 1955. L

14. Russell, R. W., Effect of Variations in Ambient Temperature on Certain Measures of Tracking Skill and Sensory Sensitivity, AMRL Report 300, Fort Knox, Kentucky, November 1957. AD 146 210.
15. Teichner, W. H., "Recent Studies of Simple Reaction Time," Psychol. Bull., Vol 51, pp 128-149, 1954.
16. Teichner, W. H., "Reaction Time in the Cold," J. Appl. Psychol., Vol 42, pp 54-59, 1958. L
17. Teichner, W. H., and J. L. Koblrick, Effects of Prolonged Exposure to Low Temperature on Visual Motor Performance, Flicker Fusion and Pain Sensitivity, QRDC Report 230, Natick, Massachusetts, June 1954. AD 33 972. L
18. Williams, C. C., and J. A. Kitching, The Effects of Cold on Human Performance, NRCC, Ottawa, Canada, March 1942. AD 116 282. L

## SECTION II

## ATTENTION (VIGILANCE) AND PERCEPTION

19. Barmack, J. E., "Studies on the Psychophysiology of Boredom: Part 2. The Effect of a Lowered Room Temperature and an Added Incentive on Blood Pressure, Report of Boredom and Other Factors," J. Exp. Psychol., Vol 25, pp 634-642, 1939. L
20. Bursall, A. E., "The Restriction of Peripheral Vision During Exposure to Hot and Humid Conditions," Quart. J. Exp. Psychol., Vol 10, pp 113-129, 1958. H
21. Carlson, L. D., Human Performance under Different Thermal Loads, SAM Report 61-43, Aero Medical Center, BAFB, Texas, March 1961. AD 254 374. L
22. Fine, B. J., A. Cohen, and B. Crist, "Effect of Exposure to High Humidity at High and Moderate Ambient Temperatures on Anagram Solution and Auditory Discrimination," Psychol. Rep., Vol 7, pp 171-181, 1960. AD 251 918. H
23. Fraser, D. C., "Relationship of an Environmental Variable to Performance in a Prolonged Visual Task," Quart. J. Exp. Psychol., Vol 5, pp 31-32, 1953. H
24. Fraser, D. C., "Some Effects of Heat Stress on Performance of a Vigilance Task under Speed Stress," NCB Medical Research Memo Number 1, England, 1957. H
25. Fraser, D. C., and K. F. Jackson, "Effect of Heat Stress on Serial Reaction Time in Man," Nature, Vol 176, pp 976-977, 1955. H
26. Horvath, S. M., and A. Freedman, "The Influence of Cold upon the Efficiency of Man," J. Aviat. Med., Vol 18, pp 158-164, 1947. L
27. Leob, M., and G. Jeantheau, "The Influence of Noxious Environmental Stimuli on Vigilance," J. Appl. Psychol., Vol 42, pp 47-49, 1958. H
28. Mackworth, N. H., Effects of Heat and High Humidity on Wireless Telegraphy Operators Hearing and Recording Morse Messages, RNP Report 45/243, London, England, October 1945. H
29. Mackworth, N. H., "Effects of Heat on Wireless Operators Hearing and Recording Morse Code Messages," Brit. J. Industr. Med., Vol 3, pp 143-157, 1946. (Summarizes Ref. 28.) H
30. Mackworth, N. H., Effects of Heat and High Humidity on Prolonged Visual Search as Measured by the Clock Test, RNP Report 46/278, London, England, February 1946. H
31. Mackworth, N. H., "Researches on the Measurement of Human Performance," In Sinaiki, H. W., (Ed.), Selected Papers on Human Factors in the Design and Use of Control Systems, Paper 7, pp 174-331, Dover Publications, Inc., New York N. Y., 1961. (In part summarizes Refs. 28, 29, and 30.) H

32. Pepler, R.D., The Effect of Climatic Factors on the Performance of Skilled Tasks by Young European Men Living in the Tropics IV. A Task of Prolonged Visual Vigilance, RNP Report 53/764, London, England, January 1953. H
33. Pepler, R.D., The Effect of Climatic Factors on the Performance of Skilled Tasks by Young European Men Living in the Tropics: A Task of Morse Code Reception, RNP Report 53/769, London, England, February 1953. AD 22 166. H
34. Pepler, R.D., "Warmth and Performance: An Investigation in the Tropics," Ergonomics, Vol 2, pp 63-88, 1958. (In part summarizes Ref. 32.) H
35. Viteles, M.S., and K.R. Smith, "An Experimental Investigation of the Effect of Change in Atmospheric Conditions and Noise upon Performance," Heating, Piping & Air Conditioning, ASHVE, New York, New York, Vol 18, pp 107-112, March 1946. H
36. Williams, C.C., and J.A. Kitching, The Effects of Cold on Human Performance, NRCC, Ottawa, Canada, March 1942. AD 116 282. L

## SECTION III

## PSYCHOMOTOR PERFORMANCE

37. Aiken, E.G., Combined Environmental Stresses and Manual Dexterity, AMRL Report 225, Fort Knox, Kentucky, March 1956. AD 89 327.
38. Armstrong, H.G., "The Loss of Tactical Efficiency of Flying Personnel in Open Cock-Pit Aircraft Due to Cold Temperature," Military Surgeon, Vol 79, pp 133-140, 1936. L
39. Barmack, J.E., "Studies on the Psychophysiology of Boredom: Part 2. The Effect of a Lowered Room Temperature and an Added Incentive on Blood Pressure, Report of Boredom and Other Factors," J. Exp. Psychol., Vol 25, pp 634-642, 1939. L
40. Bartlett, D.J., and D.G.C. Gronow, Manual Dexterity and Tactile Sensitivity in the Cold, FPRC Report 806, RAF IAM, England, November 1952. AD 108 827. L
41. Bedford, T., "Air Conditioning and Health of Industrial Worker," Inst. of Heating and Ventilating Eng. J., Vol 17, p 112, 1949. H
42. Blockley, W.V., and J.H. Lyman, Studies of Human Tolerance for Extreme Heat-IV-Psychomotor Performance of Pilots as Indicated by Task Simulating Aircraft Instrument Flight, WADC Technical Report 6521, WPAFB, Ohio, May 1951. ATI 119 608. H
43. Bursill, A.E., "The Restriction of Peripheral Vision During Exposure to Hot and Humid Conditions," Quart. J. Exp. Psychol., Vol 10, pp 113-129, 1958. H
44. Carpenter, A., A Preliminary Experiment on the Effect of Air Movement on the Pursuit-Meter Test at High Room Temperatures, RNP Report 47/397, London, England, June 1947. H
45. Carpenter, A., A Comparison of the Effects of Handle Load and of Unfavourable Atmospheric Conditions on the Performance of the Pursuitmeter Test, RNP Report 47/361, London, England, 1947. H
46. Clark, R.E., and A. Cohen, Manual Performance as a Function of Rate of Change in Hand Skin Temperature, QRDC Technical Report EP-144, Natick, Massachusetts, January 1961. AD 251 936. L
47. Craik, K.J.W., and S.J. Macpherson, Effects of Cold upon Hand Movement and Reaction Time, MPRC-BPC Report 43/196, CAV, England, 1943. L
48. Dusek, E.R., Manual Performance and Finger Temperature as a Function of Ambient Temperature, QRDC Technical Report EP-68, October 1957. AD 148 222. L
49. Forlano, G., "The Effect of Ambient and Body Temperatures upon Reaction Time," Tech. Data Digest, Vol 15, pp 18-26, 1950.
50. Forlano, G., J.E. Barmack, and J.D. Coakley, The Effect of Ambient and Body Temperatures upon Reaction Time, SDC Report R-151-1-13, ONR, Washington, D.C., March 1948. ATI 41 253.

51. Gaydos, H. F., "Effect on Complex Manual Performance of Cooling the Body while Maintaining the Hands at Normal Temperatures," J. Appl. Physiol., Vol 12, pp 373-376, 1958. L
52. Gaydos, H. F., and E.R. Dusek, Effects of Localized Cooling of the Hands Versus Total Body Cooling on Performance of a Complex Manual Task, QRDC Technical Report EP-65, August 1957. AD 142 867. L
53. Gaydos, H. F., and E.R. Dusek, "Effects of Localized Hand Cooling Versus Total Body Cooling on Manual Performance," J. Appl. Physiol., Vol 12, pp 377-380, 1958. (Summarizes Ref. 52.) L
54. Horvath, S. M., and A. Freedman, "The Influence of Cold upon the Efficiency of Man," J. Aviat. Med., Vol 18, pp 158-164, 1947. L
55. LeBlanc, J. S., Impairment of Manual Dexterity in the Cold, DRNL Report 4/55, Fort Churchill, Manitoba, Canada, 1955. AD 119 292. L
56. Lundervold, A., "Electromyographic Investigation During Typewriting," Ergonomics, Vol 1, pp 226-233, 1958. L
57. MacCanon, D. M., Effect of Oxygen Inhalation on Manual Performance in the Cold, AMRDC Progress Report, Contract DA-49-007-MD-1008, DA, Washington 25, D.C., April 1961. AD 256 708. L
58. Mackworth, N. H., Effects of Heat and High Humidity on Pursuitmeter Scores, RNP Report 45/199, London, England, 1945. H
59. Mackworth, N. H., Effects of Heat and High Humidity on Wireless Telegraphy Operators Hearing and Recording Morse Messages, RNP Report 45/243, London, England, October 1945. H
60. Mackworth, N. H., "Effects of Heat on Wireless Operators Hearing and Recording Morse Code Messages," Brit. J. Industr. Med., Vol 3, pp 143-185, 1946. (Summarizes Ref. 59.) H
61. Mackworth, N. H., "Research on the Measurement of Human Performance," In Sinaiki, H. W., (Ed.), Selected Papers on Human Factors in the Design and Use of Control Systems, Paper 7, Dover Publications, Inc., New York, N.Y., 1961. (In part summarizes Refs. 58, 59, and 60.) H
62. McCleary, R. A., Psychophysiological Effects of Cold. The Role of Skin-Temperature and Sensory Sensitivity in Manual Performance Decrement, SAM Project 21-1202-0004, Report 1, RAFB, Texas, January 1953. AD 8093. L
63. Miller, H. R., A Simple Procedure for Warming the Hands to Maintain Dexterity During Exposure to Extreme Cold, SCGSA Engineering Memorandum 18 CR, CRU, Fort Monmouth, New Jersey, July 1944. AD 124 927. L
64. Newton, J. M., An Investigation of Tracking Performance in the Cold with Two Types of Control, AMRL Report 324, Fort Knox, Kentucky, September 1957. AD 160 342. L

65. Newton, J. M., and L. J. Peacock, The Effects of Auxiliary Tropical Heat on Manual Dexterity in the Cold, AMRL Report 285, Fort Knox, Kentucky, December 1956. AD 135 239. L
66. Payne, R. B., "Tracking Proficiency as a Function of Thermal Balance," J. Appl. Physiol., Vol 14, pp 387-389, 1959.
67. Peacock, L. J., A Field Study of Rifle Aiming Steadiness and Serial Reaction Performance as Affected by Thermal Stress and Activity, AMRL Report 231, Fort Knox, Kentucky, April 1956. AD 92 230.
68. Pepler, R. D., The Effect of Climatic Factors on the Performance of Skilled Tasks by Young European Men Living in the Tropics: A Task of Continuous Pointer Alignment - Experiment One, RNP Report 53/766, London, England, January 1953. H
69. Pepler, R. D., The Effect of Climatic Factors on the Performance of Skilled Tasks by Young European Men Living in the Tropics: A Task of Continuous Pointer Alignment - Experiment Two, RNP Report 53/768, London, England, February 1953. AD 22 164. H
70. Pepler, R. D., The Effect of Climatic Factors on the Performance of Skilled Task by Young European Men Living in the Tropics: A Task of Morse Code Reception, RNP Report 53/769, London, England, February 1953. AD 22 166. H
71. Pepler, R. D., The Effect of Climatic Factors on the Performance of Skilled Tasks by Young European Men Living in the Tropics: A Task of Continuous Pointer Alignment at Two Levels of Incentive, RNP Report 54/795, London, England, November 1953. H
72. Pepler, R. D., Extreme Warmth and Sensori-Motor Coordination, APU Report 287/58, London, England, July 1958. H
73. Pepler, R. D., "Warmth and Performance: An Investigation in the Tropics," Ergonomics, Vol 2, pp 63-88, 1958. (In part summarizes Refs. 68, 69, and 71.) H
74. Pepler, R. D., "Warmth and Lack of Sleep: Accuracy or Activity Reduced," J. Comp. & Physiol. Psychol., Vol 52, pp 446-450, 1959. H
75. Pepler, R. D., "Warmth, Glare and a Background of Quiet Speech: A Comparison of Their Effects on Performance," Ergonomics, Vol 3, pp 68-73, 1960. H
76. Rohles, F. H., Jr., Two Studies on Temperature and Motor Ability: The Effects of Temperature on Serial-Discriminative Responses: The Effect of Time and Temperature on Motor Ability, AAL Project 22-0601-0002, Report 1, LAFB, Alaska, November 1953. AD 52 956. L
77. Rubin, L. S., "Manual Dexterity of the Gloved and Bare Hand as a Function of the Ambient Temperature and Duration of Exposure," J. Appl. Psychol., Vol 41, pp 377-383, 1957. L
78. Russell, R. W., "Environmental Conditions and Behaviour: Effects of Climate. Effects of Varying Ambient Temperature on Tactile and Kinaesthetic Sensitivity and on Certain Tracking Skills," Bull. Brit. Psychol. Soc., Vol 26 (Inset), p 5, 1955.



79. Russell, R. W., Effect of Variations in Ambient Temperature on Certain Measures of Tracking Skill and Sensory Sensitivity, AMRL Report 300, Fort Knox, Kentucky, November 1957. AD 146 210.
80. Springbett, B. M., The Effects of Exposure to Cold on Motor Performance, L  
DRNL, Canada, 1951. AD 6753.
81. Teichner, W.H., "Manual Dexterity in the Cold," J. Appl. Psychol., L  
Vol 11, pp 333-338, 1957.
82. Teichner, W.H., and J.L. Kobrick, Effects of Prolonged Exposure to Low Temperature on Visual-Motor Performance, Flicker Fusion and Pain Sensitivity, QRDC Report 230, Natick, Massachusetts, June 1954. AD 33 972. L
83. Teichner, W.H., and J.L. Kobrick, "Effects of Prolonged Exposure to Low Temperature on Visual-Motor Performance," J. Exp. Psychol., L  
Vol 49, pp 122-126, 1955.
84. Teichner, W.H., and R. F. Wehrkamp, "Visual-Motor Performance as a Function of Short-Duration Ambient Temperature," J. Exp. Psychol.,  
Vol 47, pp 447-450, 1954. AD 3355.
85. Viteles, M. S., and K.R. Smith, A Psychological and Physiological Study of the Accuracy, Variability and Volume of Work of Young Men in Hot Spaces with Different Noise Levels, ASHVE Report to Air Concitioning Section, Design Division, Bureau of Ships, United States Navy, 1941. H
86. Viteles, M. S., and K.R. Smith, "An Experimental Investigation of the Effect of Change in Atmospheric Conditions and Noise upon Performance," Heating, Piping & Air Conditioning, ASHVE, New York, New York, Vol 18, H  
pp 107-112, March 1946.
87. Watkins, E. S. "The Effects of Heat on Psychomotor Efficiency; with Particular Reference to Tropical Man," Unpublished Doctor's Thesis University of Liverpool, England, 1956. H
88. Weiner, J. S., and J. C. D. Hutchinson, "Hot Humid Environment: Its Effect on the Performance of a Motor Coordination Test," Brit. J. Industr. Med., Vol 2, pp 154-157, 1945. H
89. Williams, C. C., and J. A. Kitching, The Effects of Cold on Human Performance, NRCC, Ottawa, Canada, March 1942. AD 116 282. L

## SECTION IV

## HEAVY OR PROLONGED PHYSICAL WORK

90. Bean, W.B., and L.W. Eichna, "Performance in Relation to Environmental Temperature," Fed. Proc., Vol 2, pp 144-158, 1943. H
91. Bean, W.B., L.W. Eichna, W.F. Ashe, S.M. Horvath, and N. Nelson, Studies of Men in Simulated Desert Heat, AMRL Report 2(2-11, 2-12, 2-13, 2-17), Fort Knox, Kentucky, April 1943. H
92. Bedford, T., Basic Principles of Ventilation and Heating, H.K. Lewis and Co. Ltd., London, England, 1948. H
93. Benson, R.S., T. Clover, W.S.S. Ladell, B. McArdle, and J.W. Scott, The Ability to Work in Severe Heat, RNP Report 45/205, London, England, June 1945. H
94. Brouha, L., and M.E. Maxfield, "Practical Evaluation of Strain in Muscular Work and Heat Exposure by Heart Rate Recovery Curves," Ergonomics, Vol 5, pp 87-92, 1962. H
95. Cooke, H.M., C.H. Wyndham, N.B. Strydom, J.S. Maritz, G.A.G. Bredell, V.W. Kleyn, J.F. Morrison, J. Peter, and C.G. Williams, "The Effects of Heat on the Performance of Work Underground," Mine Vent. J., pp 177-196, October 1961. H
96. Edholm, O.G., J.M. Adam, and R.H. Fox, "The Effect of Work on Pulse Rate in Temperate and Hot Conditions," Ergonomics, Vol 5, p 86, 1962. H
97. Eichna, L.W., W.B. Bean, and W.F. Ashe, Operations at High Temperatures, AMRL Report 2(2-7, 2-11, 2-13, 2-15, 2-17, 2-19), Fort Knox, Kentucky, October 1943. H
98. Eichna, L.W., W.F. Ashe, W.B. Bean, and W.B. Shelley, "The Upper Limits of Environmental Heat and Humidity Tolerated by Acclimatized Men Working in Hot Environments," J. of Industr. Hygiene and Toxicology, Vol 27, pp 59-84, 1945. H
99. Eighteenth Annual Report of the Industrial Health Research Board, Medical Research Council, London, England, 1938. H
100. Herrington, L.P., "Human Efficiency and Comfort in Indoor Climates," Heating and Ventilating Engrs. J., p 53, July 1950. H
101. Horvath, S.M., and W.B. Shelley, "Acclimatization to Extreme Heat and its Effects on the Ability to Work in Less Severe Environments," Amer. J. Physiol., Vol 146, pp 336-343, 1946. H
102. Houghten, F.C., Work Performance of Young Men in Comfortable and Hot Atmospheres with Different Noise Levels, ASHVE Research Laboratory Report, 1942. H

103. Liberson, W., and P. Marques, "Experiments on Work in High Temperatures in an Artificial Mine," Trav. Humain, England, Vol 2(1), pp 39-69, 1934. H
104. Lifson, K.A., "Production Welding in Extreme Heat," Ergonomics, Vol 1, pp 345-347, 1958. H
105. Mackworth, N.H., High Incentives Versus Hot and Humid Atmospheres in a Physical Effort Task, RNP Report 47/376, London, England, August 1947. H
106. Mackworth, N.H., "High Incentives Versus Hot and Humid Atmospheres in a Physical Effort Task," Brit. J. Psychol., Vol 39, pp 90-102, 1948. (Summarizes Ref 105.) H
107. Mackworth, N.H., "Researches on the Measurement of Human Performance," In Sinaiki, H.W. (Ed.), Selected Papers on Human Factors in the Design and Use of Control Systems, Paper 7, pp 174-331, Dover Publications, Inc., New York, N.Y., 1967. (In part summarized Refs. 105 and 106.) H
108. Nelson, N., L.W. Eichna, and W.B. Bean, High Temperatures in Tanks, AMRL Report 2-6, Fort Knox, Kentucky, May 1943. H
109. "Physiological Principles," Heating Ventilating Air Conditioning Guide 1950, Chapter Chapter 6, American Society of Heating and Ventilating Engineers, New York, N.Y., 1950. H
110. Provins, K.A., "Environmental Conditions and Driving Efficiency: A Review," Ergonomics, Vol 2, pp 97-107, 1958. H
111. Seymour, W.D., "Human Aspects of Heating and Ventilation," Industr. Heating Engr., Vol 2, Nos. 5, 6, 7, 8, and 9, January 1940, p 3, April 1940, p 39, July 1940, p 75, October 1940, p 92, and January 1941, p 1. H
112. Shelley, W.B., L.W. Eichna, and S.M. Horvath, "The Effect of Clothing on the Ability of Men to Work in Intense Heat," J. Clin. Invest., Vol 25, pp 437-446, 1946. H
113. Taylor, C.L., "Physical Exertion in the Heat," J. Aviat. Med., Vol 17, p 137, 1946. H
114. Ventilation: Report of the New York State Commission on Ventilation, Dulton, New York, N.Y., 1923. H
115. Vernon, H.M., Accidents and Their Prevention, Cambridge University Press, Cambridge, Massachusetts, 1936. H
116. Winslow, C.E.A., and L.P. Herrington, Temperature and Human Life, Princeton University Press, Princeton, New Jersey, 1949. H
117. Wyndham, C.H., N.B. Strydom, J.F. Morrison, F.D. DuToit, and J.G. Kraan, "Responses of Unacclimatized Men under Stress of Heat and Work," J. Appl. Physiol., Vol 6, p 681, 1954. H
118. Yaglou, C.P., and A. Messer, Performance of a "Desert Group" Versus a "Temperate Group" of Young Men in the Desert of Yuma, RDD Contract DA-49-007-MD-203, DA, Washington, D.C., February 1958. AD 158 521. H
119. Yaglou, C.P., N. Glickman, and A. Messer, Performance of Young Floridians in the Humid Heat of Southern Florida, RDD Contract DA-49-007-MD-203, DA, Washington, D.C., February 1959. AD 213 619. H

## SECTION V

## MENTAL PERFORMANCE

120. Armstrong, H.G., "The Loss of Tactical Efficiency of Flying Personnel in Open Cock-Pit Aircraft Due to Cold Temperature," Military Surgeon, Vol 79, pp 133-140, 1936. L
121. Bartlett, D.J., and D.G.C. Gronow, The Effects of Heat Stress on Mental Performance, FRPC Report 846, RAF IAM, England, August 1953. AD 30 748. H
122. Blockley, W.V., and J.H. Lyman, Studies of Human Tolerance for Extreme Heat. III. Mental Performance under Heat Stress as Indicated by Addition and Number Checking Test, AF Technical Report 6022, AMC, WPAFB, Dayton, Ohio, October 1950. ATI 95 445. H
123. Carpenter, A., The Effect of Room Temperature on the Performance of the Resistance Box Test: A Performance Test of Intelligence, RNP Report 46/318, London, England, August 1946. H
124. Chiles, W.D., Effects of Elevated Temperatures on Performance of a Complex Mental Task, WADC Technical Report 57-726, WPAFB, Ohio, December 1957. AD 142 192. H
125. Chiles, W.D., Effects of High Temperatures on Performance of a Complex Mental Task, WADC Technical Report 58-323, WPAFB, Ohio, July 1958. AD 155 811. H
126. Chiles, W.D., "Effects of Elevated Temperatures on Performance of a Complex Mental Task," Ergonomics, Vol 2, pp 89-96, 1958. (Summarizes results of Refs. 124 and 125.) H
127. Fine, B.J., "The Comparative Effectiveness of Some Psychological and Physiological Measures in Ranking the Impact of Diverse Environmental Conditions," J. Appl. Psychol., Vol 42, pp 353-356, 1958. L
128. Fine, B.J., "The Effect of Exposure to an Extreme Stimulus on Judgment of Some Stimulus-Related Words," J. Appl. Psychol., Vol 45, pp 41-44, 1961. L
129. Fine, B.J., A. Cohen, and B. Crist, "Effect of Exposure to High Humidity at High and Moderate Ambient Temperatures on Anagram Solution and Auditory Discrimination," Psychol. Rept., Vol 7, pp 171-181, 1960. AD 251 918. H
130. Givoni, B., and Y. Rim, "Effect of the Thermal Environment and Psychological Factors upon Subject's Responses and Performance of Mental Work," Ergonomics, Vol 5, pp 99-114, 1962. H
131. Lyman, J.H., "Addition and Number Checking Test Performance of Men in Extreme Thermal Environments," Amer. Psychologist, Vol 5, p 469, 1950. (Summarizes Ref. 122.) H
132. Mayo, G.D., "Effect of Temperature upon Technical Training," J. Appl. Psychol., Vol 39, pp 244-246, 1955. H

133. Mackworth, N.H., Effects of Heat and High Humidity on Wireless Telegraphy Operators Hearing and Recording Morse Messages, RNP Report 45/243, London, England, October 1945. H
134. Mackworth, N.H., "Effects of Heat on Wireless Operators Hearing and Recording Morse Code Messages," Brit. J. Industr. Med., Vol 3, pp 143-158, 1946. H
135. Mackworth, N.H., "Researches on the Measurement of Human Performance," In Sinaiki, H.W., (Ed.), Selected Papers on Human Factors in the Design and Use of Control Systems, Paper 7, pp 174-331, Dover Publications, Inc., New York, N.Y., 1961. (In part summarizes Refs. 133 and 134.) H
136. Pepler, R.D., The Effect of Climatic Factors on the Performance of Skilled Tasks by Young European Men Living in the Tropics: A Complex Mental Task with Varying Speed Stress, RNP Report 54/794, London, England, November 1953. H
137. Pepler, R.D., The Effect of Climatic Factors on the Performance of Skilled Tasks by Young European Men Living in the Tropics: A Complex Mental Task with Varying Speed Stress at Two Levels of Incentive, RNP Report 54/796, London, England, December 1953. H
138. Pepler, R.D., The Effect of Climatic Factors on the Performance of Skilled Tasks by Young European Men Living in the Tropics: A Task of Morse Code Reception, RNP Report 53/769, London, England, February 1953. AD 22 166. H
139. Pepler, R.D., "Warmth and Performance: An Investigation in the Tropics," Ergonomics, Vol 2, pp 63-88, 1958. (In part summarizes 137.) H
140. Viteles, M.S., and K.R. Smith, "An Experimental Investigation of the Effect of Change in Atmospheric Conditions and Noise upon Performance," Heating Piping & Air Conditioning, ASHVE, New York, New York, Vol 18, pp 107-112, March 1946. H

## SECTION VI

## ANALYSES AND PARTIAL REVIEWS

141. Bartlett, F., Effects on Human Performance of Various Stress Conditions, FPRC Report 961, RAF IAM, England, January 1956. AD 96 383. H
142. Bell, C.R., and K.A. Provins, "Effects of High Temperature Environmental Conditions on Human Performance," J. Occup. Med., Vol 4, pp 202-211, 1962. H
143. Bond, H. J., and R.B. Sleight, Human Factors in the Design of Desert Equipment, HEL Contract DA-36-034-ORD-1642, Aberdeen Proving Ground, December 1954. AD 51 084. H
144. Bruce, W., Man and His Thermal Environment, NRCC Technical Report 84, Ottawa, Canada, February 1960. AD 236 020.
145. Burton, A.C., and O.G. Edholm, Man in a Cold Environment, London, England, Edward Arnold Ltd, 1955. L
146. Cattell, R.B., "Measuring Anxiety, Fatigue, and Other States," Personality and Motivation Structure and Measurement, Chapter 15, World Book Company, Yonkers-on-Hudson, N.Y., 1957.
147. Chapanis, A., W.R. Garner, and C.T. Morgan, Applied Experimental Psychology: Human Factors in Engineering Design, Chapter 14, New York, N.Y., John Wiley & Son, Inc., London, England, Chapman & Hall, Ltd., 1949.
148. Connell, L., The Effect of Heat upon the Performance of Men in High-Speed Aircraft: A Critical Review, SDC Report 151-1-17, ONR, Washington, D.C., June 1948. ATI 44 173. H
149. Crowden, G.P., "A Survey of Physiological Studies of Mental and Physical Work in Hot and Humid Environments," Trans. Roy. Soc. Trop. Med. & Hyg., Vol 42(4), pp 325-340, 1949. H
150. Fine, B.J., A. Cohen, and B. Crist, "Effect of Exposure to High Humidity at High and Moderate Ambient Temperatures on Anagram Solution and Auditory Discrimination," Psychol. Rept., Vol 7, pp 171-181. AD 251 918. H
151. Groth, H., and J.H. Lyman, Measuring Performance Changes in Highly Transient Extreme Heat Stress: Rationale, Problem, and Experimental Procedures, 6570th Aerospace Medical Research Laboratories AMRL-TDR-63-1, WPAFB, Ohio, January 1963. H
152. Lyman, J.H., The Performance of Men in Extreme Heat and Environments, Unpublished Doctor's Dissertation, University of California, 1951. H
153. Mackworth, N.H., "Definition of the Upper Limit of Environmental Warmth by Psychological Tests of Human Performance," Roy. Soc. Empire Sci. Conference Rept., Vol 1, p 423, 1948. H

154. Mackworth, N.H., "Some Recent Studies of Human Stress from a Marine and Naval Viewpoint," Trans. Inst. Mar. Engrs., Vol 64, pp 1-10, 1952. H
155. Mackworth, N.H., "Researches on the Measurement of Human Performance," In Sinaiki, H.W., (Ed.), Selected Papers on Human Factors in the Design and Use of Control Systems, Paper 7, Dover Publications, Inc., New York, N.Y., 1961. H
156. Mackpherson, R.K., "An Assessment of the Thermal Environment: A Review," Brit. J. Industr. Med., Vol 19, pp 151-164, 1962. H
157. McBlair, W., D. Rambaugh, and J. Fozard, Environmental Effects on Human Performance, Including Fatigue. Part 4. Ventilation, Temperature, Humidity, SDSCF, 1955. AD 106 677. H
158. McCormick, E.J., "Atmospheric Conditions," Human Engineering, Chapter 9, McGraw-Hill Book Co., Inc., New York, N.Y., 1957.
159. McGrath, J.J., A. Harabedian, and D.N. Buckner, Review and Critique of Literature on Vigilance Performance, PTB Contract 2649 (00) NR 153-199, ONR, Washington, D.C., December 1959. AD 237 691. H
160. Provins, K.A., and R.S.J. Clarke, "The Effect of Cold on Manual Performance," J. Occup. Med., Vol 2, pp 169-176, 1960. L
161. Reversman, S.L., J.R. Hollis, and J.B. Mattson, A Literary Survey of Human Performance under Arctic Environment, RDD Technical Memo. 6, DA, Washington, D.C., December 1953. AD 63 045. L
162. Willemin, L.P., J.E. de Jung, and A Katz, Prediction of Enlisted Performance under Conditions of Extreme Cold, PRB Technical Report 1113, DA Washington 25, D.C., September 1958. AD 203 961. L

## AUTHOR INDEX

The numbers appearing after each author's name refer to the numbered entries in the bibliography. In those cases where a report by a given author is entered more than once in the bibliography, only the number of its first appearance is given in this index.

Adam, J. M.	96
Aiken, E. G.	37
Armstrong, H. G.	38
Ashe, W. F.	91, 97, 98
Barmack, J. E.	7, 19
Bartlett, D. J.	1, 121
Bartlett, F.	141
Bean, W. B.	90, 91, 97, 98, 108
Bedford, T.	41, 92
Bell, C. R.	142
Benson, R. S.	93
Blockley, W. V.	42, 122
Bond, H. J.	143
Bredell, G. A. G.	95
Brouha, L.	94
Bruce, W.	144
Buckner, D. N.	159
Bursill, A. E.	20
Burton, A. C.	145
Carlson, L. D.	21
Carpenter, A.	44, 45, 123
Cattell, R. B.	146
Chapanis, A.	147
Chiles, W. D.	4, 124, 125, 126
Clark, R. E.	46
Clarke, R. S. J.	160
Clover, T.	93
Coakley, J. D.	7
Cohen, A.	22, 46
Connell, L.	148
Cooke, H. M.	95
Craik, K. J. W.	2
Crist, B.	22
Crowden, G. P.	149
Debons, A.	4
de Jung, J. E.	162
Dusek, E. R.	48, 52, 53
DuToit, F. D.	117
Ebaugh, F. G.	5
Edholm, O. G.	96, 145
Richna, L. W.	90, 91, 97, 98, 108, 112
Feiveson, P.	8
Fine, B. J.	22, 127, 128
Forlano, G.	6, 7
Fox, R. H.	96
Fozard, J.	157
Fraser, D. C.	23, 24, 25
Freedman, A.	26
Garner, W. R.	147
Gaydos, H. F.	51, 52, 53



Givoni, B.	130
Glickman, N.	119
Gronow, D.G.C.	1, 121
Groth, H.	151
Harabedian, A.	159
Herrington, L. P.	100, 116
Hollis, J. R.	161
Horvath, S. M.	26, 91, 101, 112
Houghten, F. C.	102
Hutchinson, J. C. D.	88
Jackson, K. F.	25
Jeantheau, G.	27
Katz, A.	162
Kitching, J. A.	18
Kleitman, N.	8
Kleyn, V. W.	95
Kobrick, J. L.	17, 83
Kraan, J. G.	117
Ladell, W. S. S.	93
LeBlanc, J. S.	55
Leob, M.	27
Liberson, W.	103
Lifson, K. A.	104
Lundervold, A.	56
Lyman, J. H.	42, 122, 131, 151, 152
MacCanon, D. M.	57
Mackworth, N. H.	9, 28, 29, 30, 31, 58, 105, 106, 153, 154
Mackpherson, R. K.	156
Macpherson, S. J.	2
Maritz, J. S.	95
Marques, P.	103
Mattson, J. B.	161
Maxfield, M. E.	94
Mayo, G. D.	132
McArdle, B.	93
McBlair, W.	157
McCleary, R. A.	10
McCormick, E. J.	158
McGrath, J. J.	159
Messer, A.	118, 119
Miller, H. R.	63
Mills, A. W.	11
Morgan, C. T.	147
Morrison, J. F.	95, 117
Morton, R.	12
Nelson, N.	91, 108
Newton, J. M.	64, 65
Payne, R. B.	66
Peacock, L. J.	65, 67
Pepler, R. D.	32, 33, 34, 68, 69, 71, 72, 74, 75, 136, 137
Peter, J.	95
Provins, K. A.	12, 110, 142, 160
Rambaugh, D.	157
Revesman, S. L.	161
Rim, Y.	130
Rohles, F. H., Jr.	76

Rubin, L. S.	77
Russell, R. W.	13, 14
Scott, J. W.	93
Seymour, W. D.	111
Shelley, W. B.	98, 101, 112
Sleight, R. B.	143
Smith, K. R.	35, 85
Springbett, B. M.	80
Strydom, N. B.	95, 117
Taylor, C. L.	113
Teichner, W. H.	15, 16, 17, 81, 83, 84
Thauer, B.	5
Titelbaum, S.	8
Vernon, H. M.	115
Viteles, M. S.	35, 85
Watkins, E. S.	87
Wehrkamp, R. F.	84
Weiner, J. S.	88
Willemin, L. P.	162
Williams, C. C.	18
Williams, C. G.	95
Winslow, C. E. A.	116
Wyndham, C. H.	95, 117
Yaglou, C. P.	118, 119

<p>Aerospace Medical Division, 6570th Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio. Rpt No. AMRL-TDR-63-13. A BIBLIOGRAPHY OF THE EFFECTS OF TEMPERATURE ON HUMAN PERFORMANCE. Final report, iv + 19 pp, 162 refs. Unclassified report</p> <p>This bibliography lists technical reports and journal articles dealing with human perform- ance under both high and low ambient temper- atures. The articles and reports have been grouped into sections covering five major per- formance areas: (1) Sensory Thresholds and</p> <p>( over )</p>	<p>UNCLASSIFIED</p> <ol style="list-style-type: none"> <li>1. Bibliography</li> <li>2. Performance Eval- uation</li> <li>3. Applied Psychology</li> <li>4. Temperatures</li> <li>5. Sensory Perception</li> <li>6. Reaction Time (Psychology)</li> <li>7. Attention</li> <li>8. Perception (Auditory and Visual)</li> <li>9. Psychomotor Tests</li> <li>I. AFSC Project 1710, Task 171002</li> </ol> <p>UNCLASSIFIED</p>	<p>Aerospace Medical Division, 6570th Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio. Rpt No. AMRL-TDR-63-13. A BIBLIOGRAPHY OF THE EFFECTS OF TEMPERATURE ON HUMAN PERFORMANCE. Final report, iv + 19 pp, 162 refs. Unclassified report</p> <p>This bibliography lists technical reports and journal articles dealing with human perform- ance under both high and low ambient temper- atures. The articles and reports have been grouped into sections covering five major per- formance areas: (1) Sensory Thresholds and</p> <p>( over )</p>	<p>UNCLASSIFIED</p> <ol style="list-style-type: none"> <li>1. Bibliography</li> <li>2. Performance Eval- uation</li> <li>3. Applied Psychology</li> <li>4. Temperatures</li> <li>5. Sensory Perception</li> <li>6. Reaction Time (Psychology)</li> <li>7. Attention</li> <li>8. Perception (Auditory and Visual)</li> <li>9. Psychomotor Tests</li> <li>I. AFSC Project 1710, Task 171002</li> </ol> <p>UNCLASSIFIED</p>
<p>Simple Reaction Time, (2) Attention and Perception, (3) Psychomotor Performance, (4) Heavy or Prolonged Physical Work, and (5) Mental Performance. A sixth section of the bibliography lists references which review portions of the literature. All the references have been coded as to whether they deal pri- marily with the effects of high or low ambient temperatures. An author index is included.</p>	<p>UNCLASSIFIED</p> <ol style="list-style-type: none"> <li>II. Behavioral Sciences Laboratory</li> <li>III. Wing, J. and Touchstone, R. M. In ASTIA collection</li> <li>V. Aval fr OTS \$0.75</li> </ol> <p>UNCLASSIFIED</p>	<p>Simple Reaction Time, (2) Attention and Perception, (3) Psychomotor Performance, (4) Heavy or Prolonged Physical Work, and (5) Mental Performance. A sixth section of the bibliography lists references which review portions of the literature. All the references have been coded as to whether they deal pri- marily with the effects of high or low ambient temperatures. An author index is included.</p>	<p>UNCLASSIFIED</p> <ol style="list-style-type: none"> <li>II. Behavioral Sciences Laboratory</li> <li>III. Wing, J. and Touchstone, R. M. In ASTIA collection</li> <li>V. Aval fr OTS \$0.75</li> </ol> <p>UNCLASSIFIED</p>